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MP MASTER
MA28069

ORIGINAL
January, 1973

OPERATING MANUAL
MODEL 8310
DIGITAL MULTIMETER

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SPECIFICATIONS

DC VOLTAGE

RANGES:	2 volts, 20 volts, 200 volts and 1000 volts full scale.
RANGING:	Full automatic.
MAXIMUM RESOLUTION:	1 millivolts on the 2 volts range.
INPUT IMPEDANCE:	1 Megohm on the 2 volts range. 10 megohms on the 20 volts thru 1000 volts ranges.
ACCURACY: (at ambient temperature of 23°C ± 10°C, and humidity less than 85%)	± 0.1% of reading ± 1 digit.
RESPONSE TIME:	0.4 sec (without range change)
NORMAL MODE REJECTION:	40 db minimum at 60 Hz ± 10%.
COMMON MODE REJECTION:	80 db minimum with 1 k unbalance at 60 Hz.

AC VOLTAGE

RANGES:	2 volts, 20 volts, 200 volts, 350 volts rms full scale.
RANGING:	Full automatic.
MAXIMUM RESOLUTION:	1 millivolts rms on the 2 volts range.
INPUT IMPEDANCE:	1 megohm.
ACCURACY: (at ambient temperature of 23°C ± 10°C, and humidity less than 85%)	± 0.3% of reading ± 0.2% of full scale on 2, 20, and 200 volts ranges. ± 0.5% of reading ± 0.5% full scale on 350 volts range.
FREQUENCY:	45 Hz to 20 KHz.
RESPONSE TIME:	2 sec (without range change)

DC CURRENT (With current measurement accessory)

RANGE: Hold on 2 volts range.

Shunt Resistance	Range	Rated Accuracy
1Ω	1 ampere full scale	± 0.5% of reading ± 1 digit
10Ω	200 milliamperes full scale	± 0.2% of reading ± 1 digit
100Ω	20 milliamperes full scale	± 0.2% of reading ± 1 digit
1 kΩ	2 milliamperes full scale	± 0.2% of reading ± 1 digit
10 kΩ	200 microamperes full scale	± 1% of reading ± 1 digit
100 kΩ	20 microamperes full scale	± 1% of reading ± 1 digit

AC CURRENT (With current measurement accessory)

RANGE: Hold on 2 volts range.

FREQUENCY: 45 Hz to 20 KHz.

Shunt Resistance	Range	Rated Accuracy
1 Ω	1 ampere full scale	± 0.8% of reading ± 0.2% of full scale
10 Ω	200 milliamperes full scale	± 0.8% of reading ± 0.2% of full scale
100 Ω	20 milliamperes full scale	± 0.8% of reading ± 0.2% of full scale
1 kΩ	2 milliamperes full scale	± 0.8% of reading ± 0.2% of full scale
10 kΩ	200 microamperes full scale	± 0.8% of reading ± 0.2% of full scale

RESISTANCE

RANGES: 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, 200MΩ full scale.

MAXIMUM RESOLUTION: 100 milliohms on the 200Ω range.

RANGING: Full automatic (Manual Ω, kΩ, MΩ function switching)

Range	Impressed Current	Rated Accuracy
200 Ω	10 milliamperes	± 0.5% of reading ± 1 digit
2 kΩ	1 milliampere	± 0.5% of reading ± 1 digit
20 kΩ	100 microamperes	± 0.5% of reading ± 1 digit
200 kΩ	10 microamperes	± 0.5% of reading ± 1 digit
2 MΩ	1 microampere	± 1% of reading ± 1 digit
20 MΩ	100 nanoamperes	± 2% of reading ± 1 digit
200 MΩ	10 nanoamperes	± 10% of reading ± 1 digit

MAXIMUM IMPRESSED VOLTAGE: 100 volts DC or peak AC, for 10 sec between COM-OHM terminals.

GENERAL SPECIFICATIONS

OPERATING METHOD: Dual slope integration.

INPUT TERMINALS: Floating.

MAXIMUM DISPLAY: 1999 (on all ranges except DC 1000 Volts, and AC 350 volts rms)

RANGE SELECTION: Full automatic.
Manual ranging available.

SAMPLING SPEED: 2 samplings/sec.

RANGING TIME: 400 milliseconds per range change.

OVERRANGE INDICATION: All figures of each numerical display tube light and render the reading illegible.

MAXIMUM VOLTAGES: Between chassis and COM terminal ± 600 volts DC.

Between COM and VOLT terminals ± 1000 volts DC.

Between COM and OHM terminals ± 100 volts DC or peak AC for 10 sec.

POLARITY INDICATION: Automatic. Negative indication only.

DISPLAY HOLDING: Polarity, measured results, and range can be held.

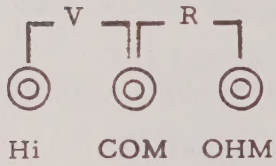
POWER CONSUMPTION: Approx. 11 VA.

POWER REQUIREMENT: 115 VAC or 230 VAC ± 10%, 50 Hz to 400 Hz.

OPERATING TEMPERATURE RANGE:	0°C to +50°C.
DIMENSIONS:	Approx. 220 mm (W) X 75 mm (H) X 214 mm (D).
WEIGHT:	Approx. 2 kg (4.6 lbs.)
ACCESSORIES:	Model 8310-800 DC high voltage probe. Model 8310-801 AC high voltage probe. Model 8310-802 AC and DC current shunts.

NOTE

Input terminals are defined in the following fashion.



Connect the two wire input cable to HI-COM while making AC and DC voltage measurements.

Connect the two wire input cable to COM-OHM while making resistance measurements.

Connect the current shunt to HI-COM and connect the two wire input cable to the current shunt while making current measurements.

GENERAL INFORMATION

1.0 DESCRIPTION

The California Instruments Model 8310 Digital Multimeter is a 3-1/2 digit, integrated circuit, dual slope integrating multimeter, which permits the measurement of DC voltage, AC voltage, and resistance at the mainframe, plus DC current and AC current measurements when used with accessory current shunts. In addition, the autoranging feature completely eliminates the tedious manual range switching operation of conventional instruments. When performing measurements, the optimum range (range providing the maximum number of digits in accordance with the input) is automatically selected after selection of the measurement function (DC voltage AC voltage, resistance). Moreover, measurements can be performed on a fixed range by merely depressing the RANGE HOLD button.

The Model 8310 Digital Multimeter has been designed to be both easy to read and use and is so compact that it can be carried either in an attache-case or with its own handle.

This instrument is guaranteed to maintain specified accuracies for 6 months after shipment and for 6 months after each calibration.

2.0 INSTALLATION AND OPERATION

2.1 GENERAL

Thoroughly inspect the instrument prior to usage for any damage which may have occurred during shipment. If the instrument has been damaged, notify the carrier or CALIFORNIA INSTRUMENTS a division of Aiken Industries, San Diego, California 92111. DO NOT ship the instrument back to CALIFORNIA INSTRUMENTS without prior approval.

2.2 CARRYING HANDLE

The handle can be set and locked in any desired position within its range of movement. To use the instrument in a tilted position, set the handle to the desired angle and use it to support the instrument.

2.3 INSPECTING THE INTERIOR

The interior connections are accessible by removing the chassis from the case. This is accomplished by removing the screws holding the chassis to the case via the rear feet as shown in Figure 1.

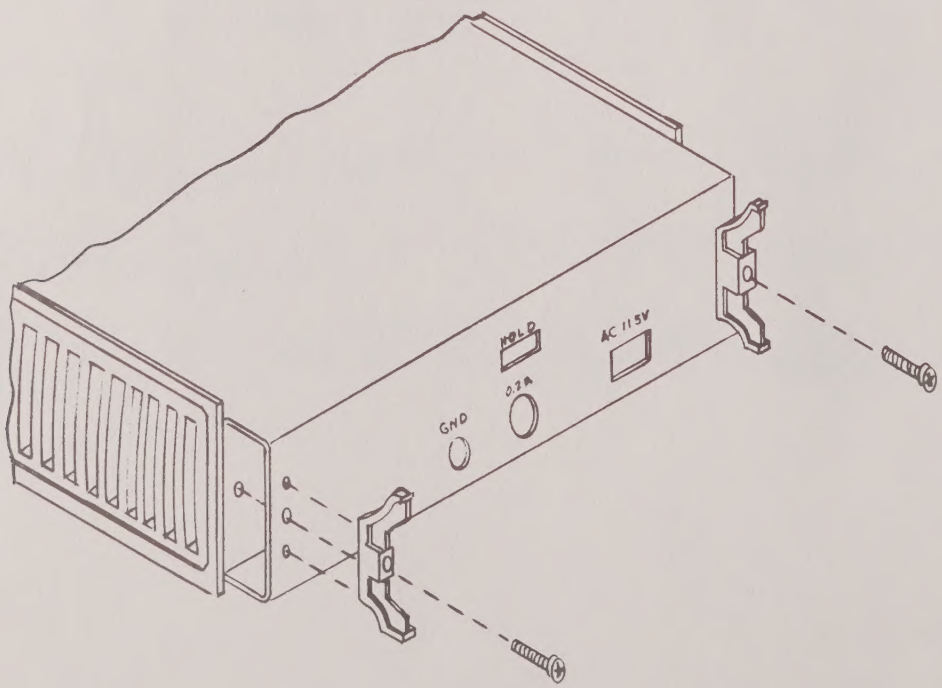


FIGURE 1. Removing the chassis of the Model 8310 Digital Multimeter from its case.

2.4 OPERATION OF FRONT PANEL CONTROLS

Figure 2 shows the front panel of the Model 8310 Digital Multimeter. The operation of the front panel controls is explained as follows:

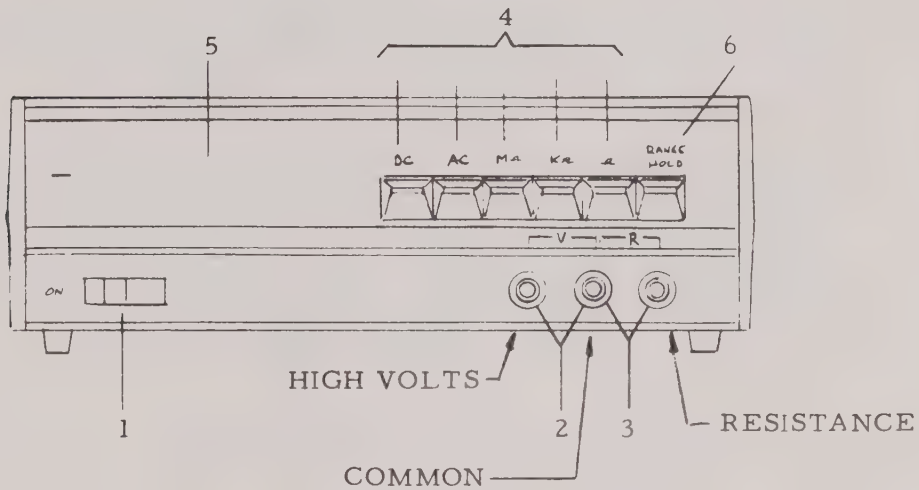


FIGURE 2. Front panel controls for the Model 8310 Digital Multimeter.

1. POWER Switch. This switch turns the instrument "on".

2. Input V terminal is the high input for measurement of AC and DC voltage. This terminal is also used as the high input for current measurement with the current measurement accessory.

3. Input R terminal is the high input for measurement of resistance.

4. Function pushbutton switches.

   DCV. This pushbutton permits the measurement of DC voltage.

   ACV. This pushbutton permits the measurement of AC voltage.

   MΩ. This pushbutton permits the measurement of resistance from 0.001 MΩ to 199.9 MΩ.

KΩ. This pushbutton permits the measurement of resistance from 0.001 kΩ to 199.9 kΩ.

Ω. This pushbutton permits the measurement of resistance from 0.1 Ω to 199.9 Ω.

5. DISPLAY

Three numerical display tubes with internal decimal points, plus the thousands digit. The decimal point position is automatically selected by the range determining circuitry.

The "-" polarity indicator automatically indicates a negative polarity when the polarity of the input voltage is negative.

6. RANGE HOLD

When the RANGE HOLD is set to a horizontal position, the range of all functions of the Digital Multimeter are automatically switched with the magnitude of the input signal. When range hold is depressed, the range immediately prior to depressing the button is held and the position of the decimal point is fixed. For example:

15.15 V Range hold depressed.

Display 15.15 V

When the input signal becomes zero.

Display 00.00 V

This operation is common to all functions.

2.5 DESCRIPTION OF REAR PANEL

Figure 3 shows the rear panel of the Model 8310 Digital Multimeter. The operation of the rear panel controls and connectors is explained on the following page.

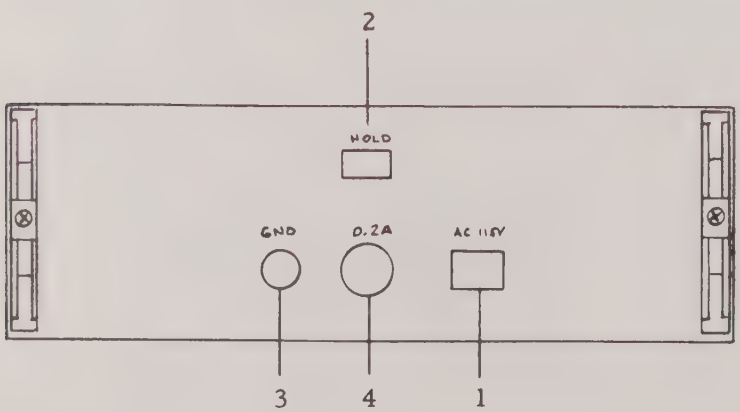


FIGURE 3. Rear Panel Controls for the Model 8310 Digital Multimeter.

1. The AC power line connector is used to supply AC power to the Digital Multimeter.

2. The display hold connector is used to hold the measured result. When the two pin connector at the rear of the instrument is shorted, the measured result immediately prior to shorting of the connector is held. The reading in the display is maintained even if the input signal is changed. For example:

   15.15 V Hold

   Display 15.15 V

   When input signal next become zero.

   Display 15.15 V

3. The GND terminal used to ground the chassis of the instrument.

4. The fuse and fuse holder are used to protect the AC input power lines in case of a short circuit in the instrument. Use a 0.2 ampere 125 VAC slow blow fuse.

MAINTENANCE AND OPERATION

OPERATION CHECK

This section describes methods of judging whether or not operation of the instrument is normal. Checks when operation is abnormal are also described.

1. POWER SUPPLY

(1) Connect the power supply cord to the instrument and turn the power switch on.

Confirm that the display lights. The display should read almost zero and the decimal point should be located between the 3rd and 4th digits when all the pushbutton switches are in the horizontal position.

When the display doesn't light, check the fuse and the display tube drive circuit 220 V line.

When the display is so dark that it cannot be read, check the 5 V line.

When the display is running, check the A-D converter and display systems.

Check the integrator output and if normal, then check the display system.

If the integrator output is abnormal, check the control logic, integrator input FET switch, and integrator comparator.

2. FUNCTION DCV and A-D CONVERTER

(1) Depress the DCV function pushbutton switch.

At this time the display should become 0.000.

When the display is running or numerals are displayed, first determine whether the trouble is in the range amplifier or the A-D converter.

Since ground is connected to the input of the A-D converter when all the function switches are in the horizontal position, if the display remains 0.000 at this time, the A-D converter is operating.

When the A-D converter is defective, check the integrator output and determine if the display system is defective or the integrator, comparator, input FET switch, or control logic system is defective.

(2) Apply a 10 V, 100 V, 1000 V voltage to obtain the 20 V range, 200 V range, and 1000 V range.

The display should coincide with the input. In addition, the decimal point should be at a suitable position.

When the range is not set, depress the range hold switch and check the sensitivity of each range. Then check the control of the reed switch of range amplifies A1.

When the input is negative, confirm that "-" is displayed at the polarity indicator. When positive, "+" is displayed.

(3) At 2 V, fix the range by depressing the range hold switch.

Next, apply a voltage over 2 V and under 10 V to the input and confirm that OVER is indicated by running of the display and by over indication. When 0800 is displayed when the input is OVER, check around the OVER memory FF.

3. FUNCTION OHM

(1) Depress only the 200Ω function switch. Short the OHM input binding post and confirm that the display reads zero. (When the input cable is connected and the clips at its end are shorted, the cable resistance of about 0.2Ω should be displayed). Connect a suitable resistance and check the display.

When the zero point is off considerably, the zero point of resistance measurement use Amp A2 has drifted.

When the correct resistance value is not displayed, check if the operation of the reed switches is normal. In addition, also check the output of A1 in accordance with Fig. 11.

(2) Depress only the kΩ function switch. Short the input and confirm that zero is displayed. Connect a suitable resistance and confirm that the display of each range is normal.

When the correct resistance value is not displayed, check if the absolute value has deviated and the sensitivity of the other ranges. Check the operation of the reed switches.

(3) Depress only the MΩ function switch. Short the input and confirm that the display reads zero. Connect a suitable resistance and confirm that the display is normal.

When the correct resistance value is not displayed, check if the absolute value has deviated and the sensitivity of the other ranges. Check the operation of the reed switches.

If the special accessory cable is not used when measuring high resistance, the insulation resistance of the cable will cause problems.

When the display is unstable, the trouble may be due to an induced voltage in the unknown resistance. The display will become stable if the black binding post terminal and instrument GND terminal (at the rear) are connected and then grounded. In addition, the resistance can also be placed in a shield case.

Moreover, when the oscillator deviates from 10 kHz, the unstability of the display will become extremely pronounced.

4. FUNCTION AC

(1) Depress only the ACV function switch.

Short the input and confirm that the display is zero. Apply a suitable value AC voltage to the input at the 2 V range and check the display.

When the correct value is not displayed, check the operation of the lead switches or the output of A1, output of A2 and input of A3.

(2) Apply a suitable AC voltage to the input to obtain the 20 V rms range, 200 V rms range and 350 V rms range and check the display value.

When the correct value is not displayed and the 2 range is normal, check A1 of the other ranges.

5. RANGE HOLD SWITCH

Depress the RANGE HOLD switch and confirm that the range remains constant no matter what the magnitude of the input. When the 200Ω function switch is depressed with the RANGE HOLD switch depressed, the decimal point should be shifted to the 200Ω range.

HOLD TERMINAL

When the HOLD terminal at the rear panel is shorted using the accessory pins, the display will be held.

ACCURACY CHECK and CALIBRATION

Test Equipment Required

The test equipment and standards required for performance checks and calibration are listed in the following table. Ample importance must be given to the accuracy of the standards in order to guarantee the performance of the multimeter.

Test Equipment

Equipment	Purpose	Required Performance		Recommended Model
DC Voltmeter	Zero point Calibration	Sensitivity 160μV resolution		Model-TR-6834 or-TR-6655
Standard DC Voltage	DC Voltage Calibration	Accuracy Range	± 0.05% 1V 1000V	Fluke 332A
Standard AC Voltage	AC Voltage Calibration	Accuracy Output Voltage Frequency	±0.1% 1V 350Vrms 40Hz 20kHz	
Standard Resistance	Resistance Calibration	Resistance	Accuracy	Guildline Type 9330
		19Ω	1.0%	
		190Ω	0.1%	
		1.9kΩ	0.1%	
		19kΩ	0.1%	
		190kΩ	0.1%	
		1.9MΩ	0.2%	
		19MΩ	0.5%	

TABLE 1

CALIBRATIONS

Preparations

Perform the Calibration Check after approximately 20 minutes of warm-up.

1. DCV ACCURACY CHECK

(1) Depress the DCV function switch.

(2) Connect the input cord to the VOLT terminal. Insert the "red" banana clip into the "red" binding rest and the "black" banana clip into the black binding post.

(3) First check the zero point and then perform the full scale check in accordance with the below table.

Input	Display	
	Maximum	Minimum
Input shorted	± 0.001	± 0.000
± 10mV	± 0.011	± 0.009
± 100mV	± 0.101	± 0.099
± 1.000V	± 1.002	± 0.998
± 1.900V	± 1.903	± 1.897
± 19.00V	± 19.03	± 18.97
± 190.0V	± 190.3	± 189.7
± 1000V	± 1002	± 0998

TABLE 2

2. ACV ACCURACY CHECK

(1) Depress the ACV function switch

(2) Connect the input cord to the VOLT terminal. Insert the red banana clip into the red binding post and the black banana clip into the black binding post.

(3) First check the zero point and then perform the following full scale check.

Input		Display	
		Maximum	Miminum
Input shorted		0.005	0.000
1.000V	400 Hz	1.008	0.992
1.900V	400 Hz	1.911	1.889
19.00V	400 Hz	19.11	18.89
190.0V	400 Hz	191.1	188.9
~~530V~~ 350V	400 Hz	0353	0347

TABLE 3

3. OHM ACCURACY CHECK

(1) Depress the MΩ, KΩ, or Ω function switch (refer to the table for the depressed switch).

(2) Short the input binding post and perform the zero check. Perform the zero check by shorting at the input binding post.

(3) Connect the input cord to the OHM terminal. Insert the "red" banana clip into the "blue" binding post and the "black" banana clip into the black binding post.

(4) Perform the full scale check.

Depressed Function Switch	Input	Display	
		Maximum	Minimum
Ω	Shorted at binding post	0.001	0.000
kΩ		0.001	0.000
MΩ		0.001	0.000
Ω	19.0 Ω	019.2 +∝ *	0.188 +∝ *
	190.0 Ω	191.1 +∝ *	188.9 +∝ *
kΩ	1.900 kΩ	1.911	1.889
	19.00 kΩ	19.11	18.89
	190.0 kΩ	191.1	188.9
MΩ	1.900 MΩ	1.920	1.880
	19.00 MΩ	19.39	18.61
	19.00 MΩ	021.0 *	0170.0 *

* ∝ = input cable impedance 0.2 Ω

* Hold the range by depressing the RANGE HOLD switch.

TABLE 4

CALIBRATION PROCEDURE

Ⓟ : Power supply board Ⓜ: Mother board Ⓐ: Auto board Ⓜ: Rear of mother board.

	Item	VR No.	Setting Range	Check point
1	Power supply 5V	R291 Ⓟ	5V±0.1V	
2	Generator	R232 Ⓜ	10,000 ±3Hz	T.P.12
3	DCV zero point	R136 Ⓜ$_A$	0.00 ±0.10mV	Measure the power supply side lead of R125 of the integrator and the ground side of the next to it. Between T.P.16 and 3 .
4	OHM zero point	R178 Ⓜ	0.00 ± 0.1mV	Same as above (input shorted)
5	AC zero point	R171 Ⓜ$_A$	0.00 ±0.10mV	Same as above (input shorted)
6	Display zero point	R190 Ⓜ	Point at which there is no shift at 0 display	Same as above (input shorted)
7	DCC 1.999V range cal.	R189 Ⓜ	1.900	Apply 1.9000V to input and adjust to obtain display reading of 1.9000.
8	DC 1.900V range cal.	R188 Ⓜ	1.900	Apply 1.900V to input and adjust to obtain reading of 1.900V.
9	DC 19.99V range cal.	R133	19.00V	Apply 19.00V to input and adjust to obtain display reading of 19.00.
10	DC 199.9V range cal.	R134	190.0V	Apply 190.0V to input and adjust to obtain display reading of 190.0.
11	DC 1000V range cal.	R135	1000V	Apply 1000V to input and adjust to obtain display reading of 100.0.
12	1.999M range cal.	R151	1.800 ±2c MΩ	Connect 1.800M to input (pay careful attention to induction) and verify that 18.00M 5 count, 180.0M 1 count is displayed.

	Item	VR No.	Setting Range	Check point
13	1.999k range cal.	R152	1.800 ± 1 c kΩ	Connect 1.800k to input and verify that 18.00M 1 count is displayed.
14	199.9k range cal.	R153	180.0 ± 1c kΩ	Connect 180.0k to input.
15	199.9 range cal.	R154	180.0 ±1c Ω	Connect 180.0 to input (calibrate by adding the resistance of the input cable).
		R-172		
16	AC 1,999V range cal.	~~R155~~	1.900 ± 1c V	Apply 400 Hz, 1.900V signal to input calibrate at 1.900V.
17	AC 350V range cal.	R173	350 ± 1c	Apply 400 Hz, 350V signal to input calibrate at 350V.
		VC No.		
18	AC 199.9V range 20 kHz cal.	C311	190.0V ± 1c	Apply 20 kHz, 190.0V signal to input, calibrate at at 190.0V.
19	AC 19.99V range 20 kHz cal.	C310	19.00V ± 1c	Apply 20kHz 19.00V signal to input, calibrate at 19.00V.
20	1.999V range 20kHz cal.	C309	1.900V ± 1c	Apply 20kHz, 1.900V signal to input, calibrate at 1.900V.

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS COMPANY a division of AIKEN INDUSTRIES INC. warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS COMPANY will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned to the Company freight prepaid, and when examination reveals that the fault has not occurred because of misuse or abnormal conditions of operation. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS COMPANY will submit an estimate for such charges before commencing repair if so requested.

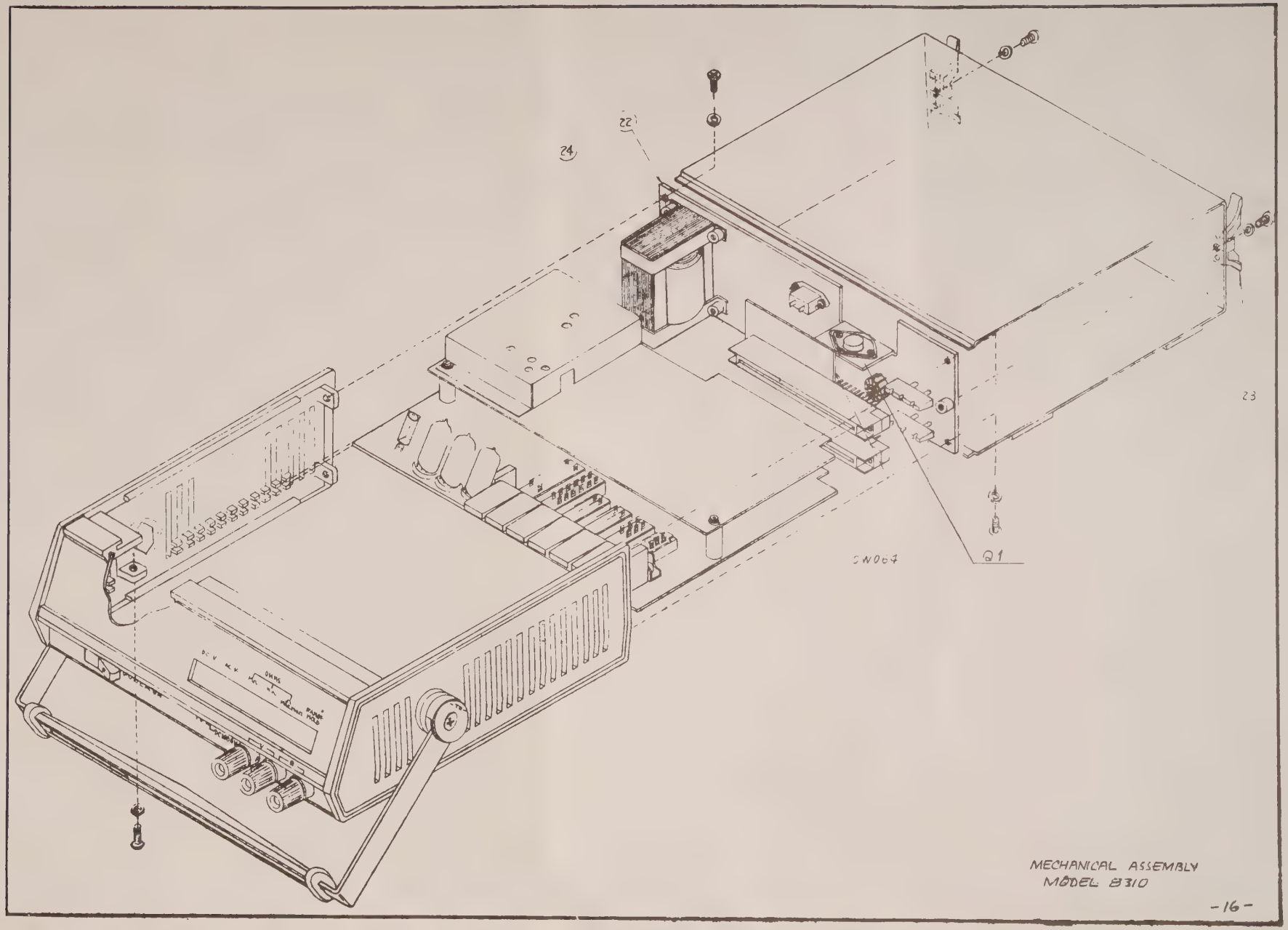
PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS COMPANY or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or shipping instructions will be furnished. If shipment is indicated, forward the instrument, freight prepaid, to the authorized repair station indicated in the instruction. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

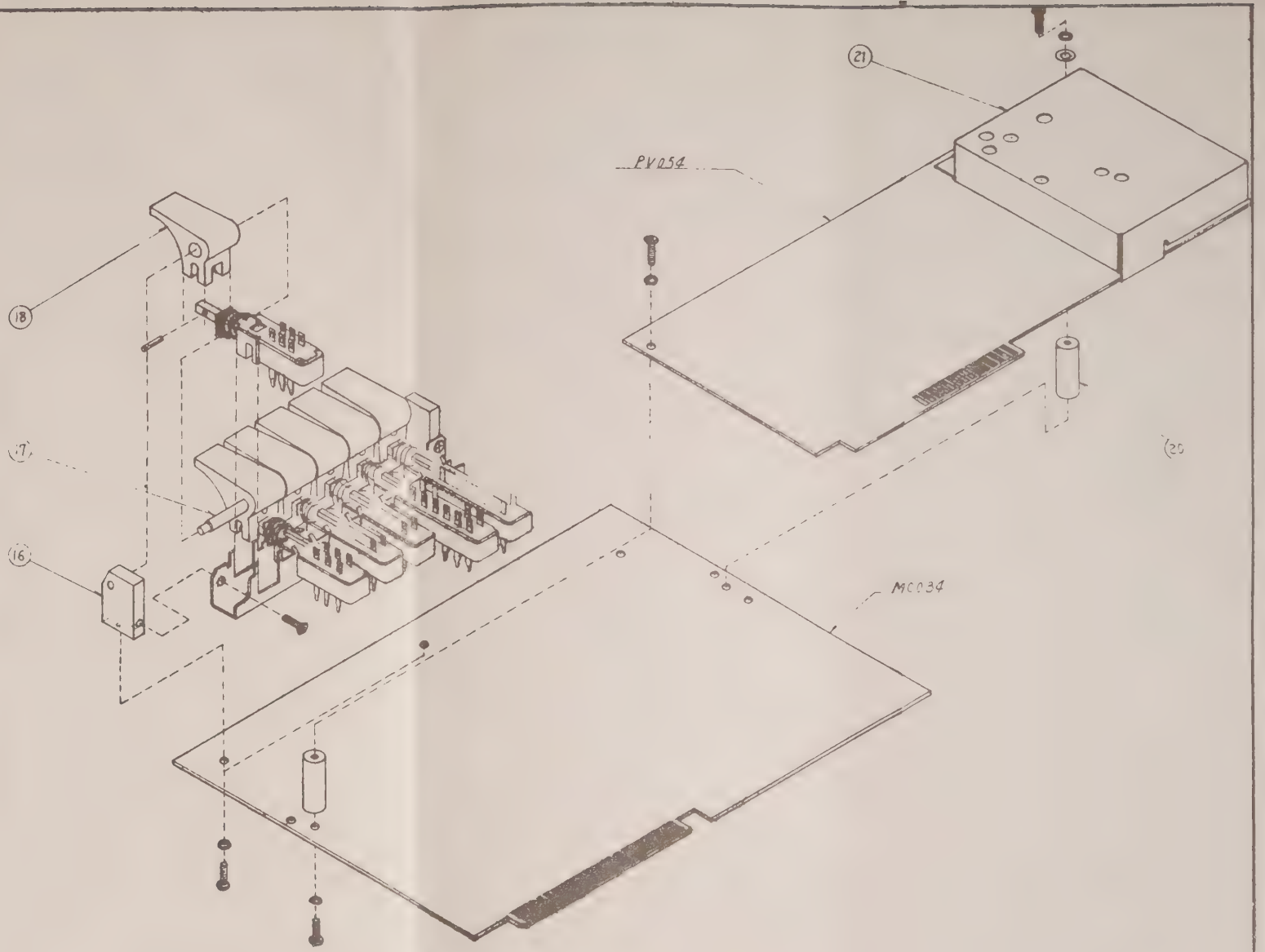
DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. CALIFORNIA INSTRUMENTS COMPANY will advise the disposition to be made of the equipment and arrange for repair or replacement. Please include model number and serial number when referring to the instrument.

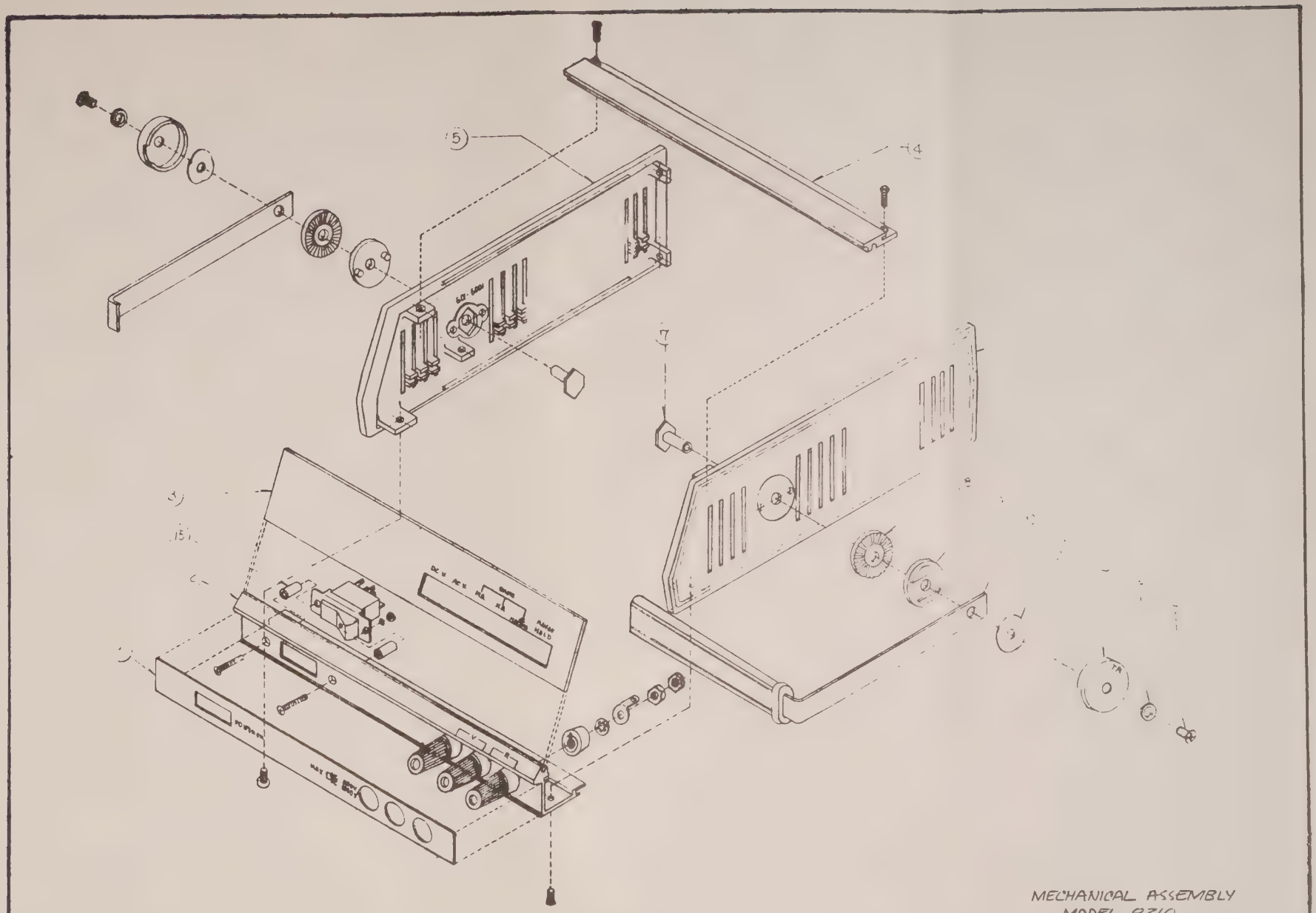
PART PLACEMENT DRAWINGS,
SCHEMATICS, AND COMPLETE
PARTS LIST.



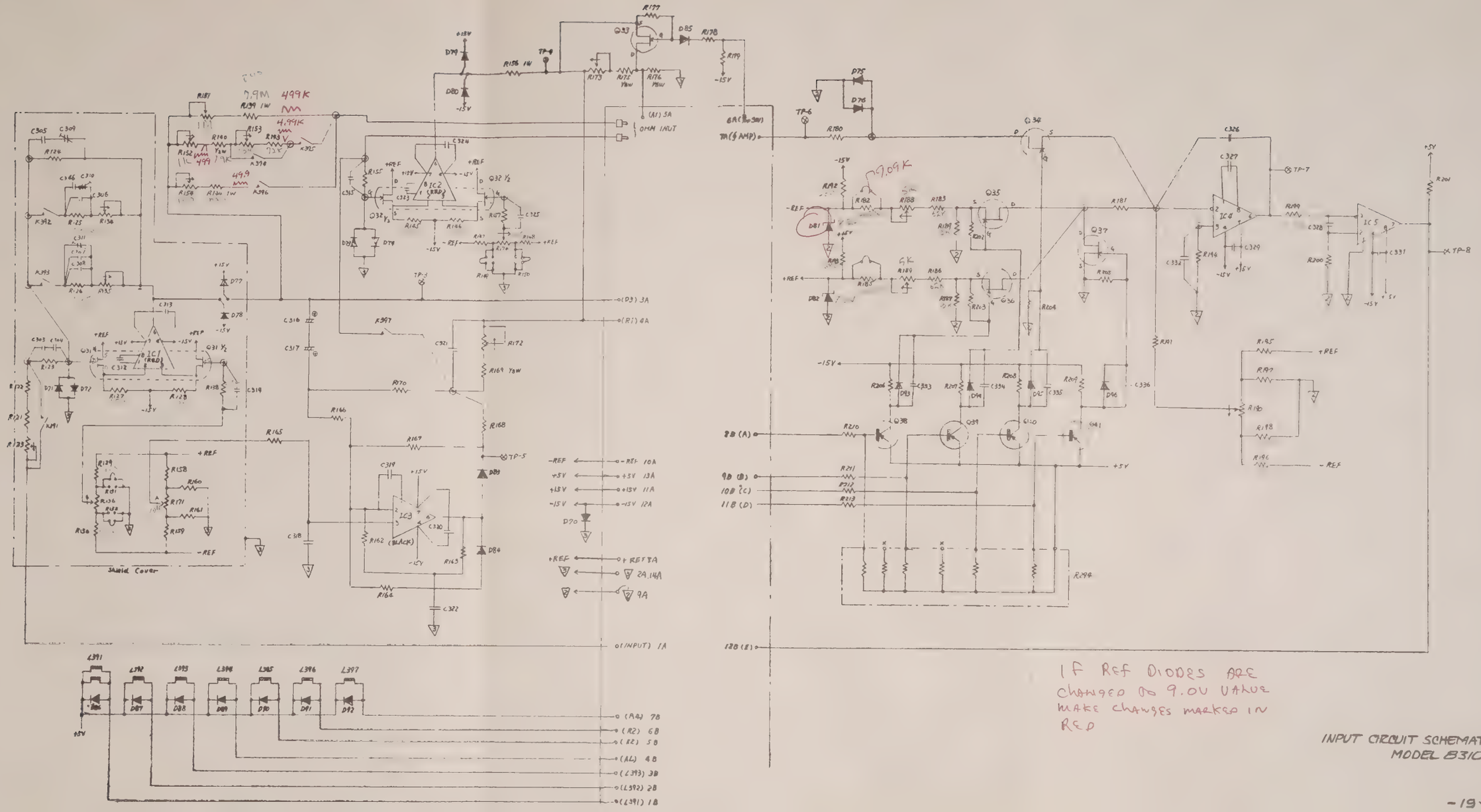
MECHANICAL ASSEMBLY
MODEL 8310



MECHANICAL ASSEMBLY
MODEL 8310

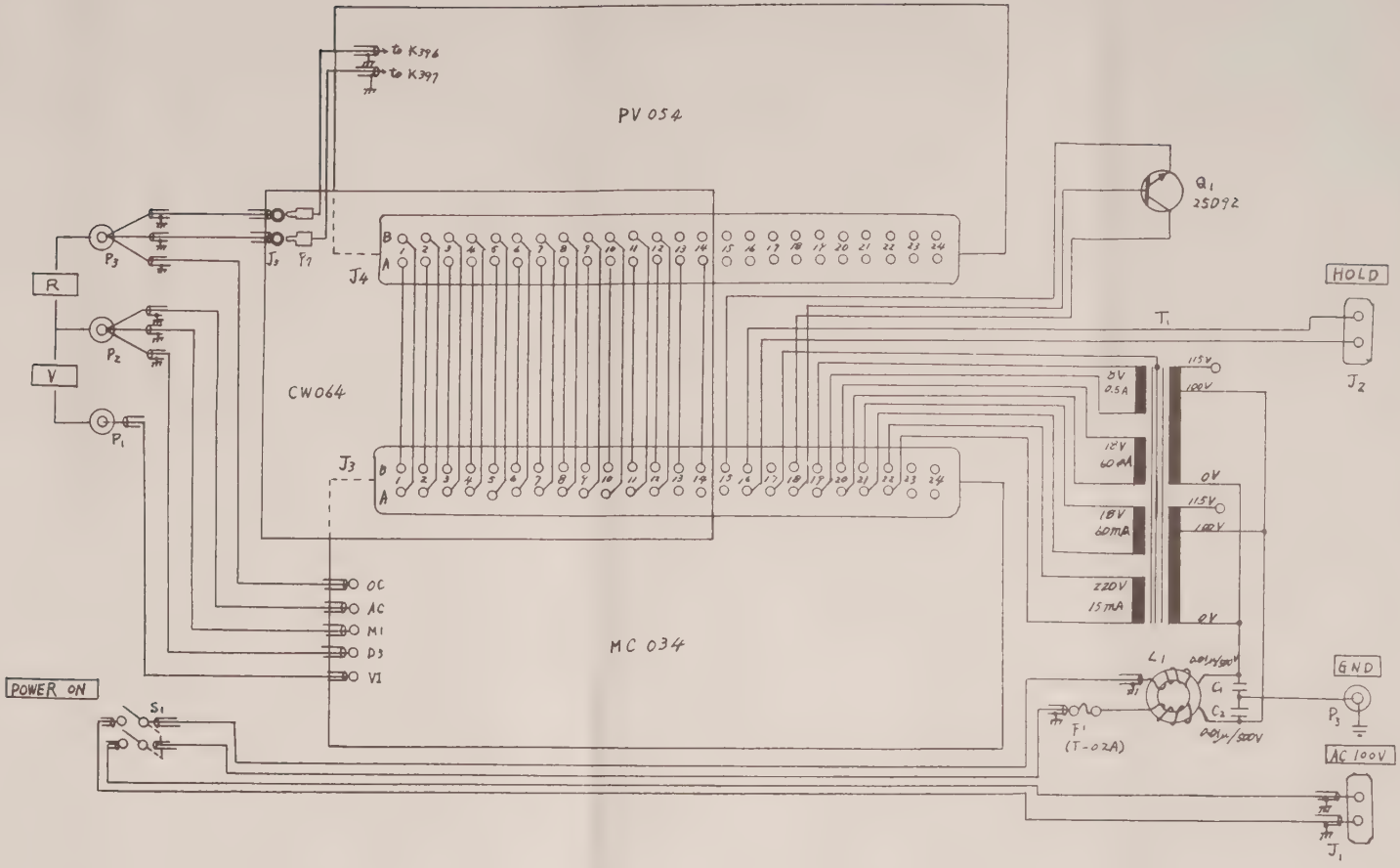


MECHANICAL ASSEMBLY
MODEL 8310

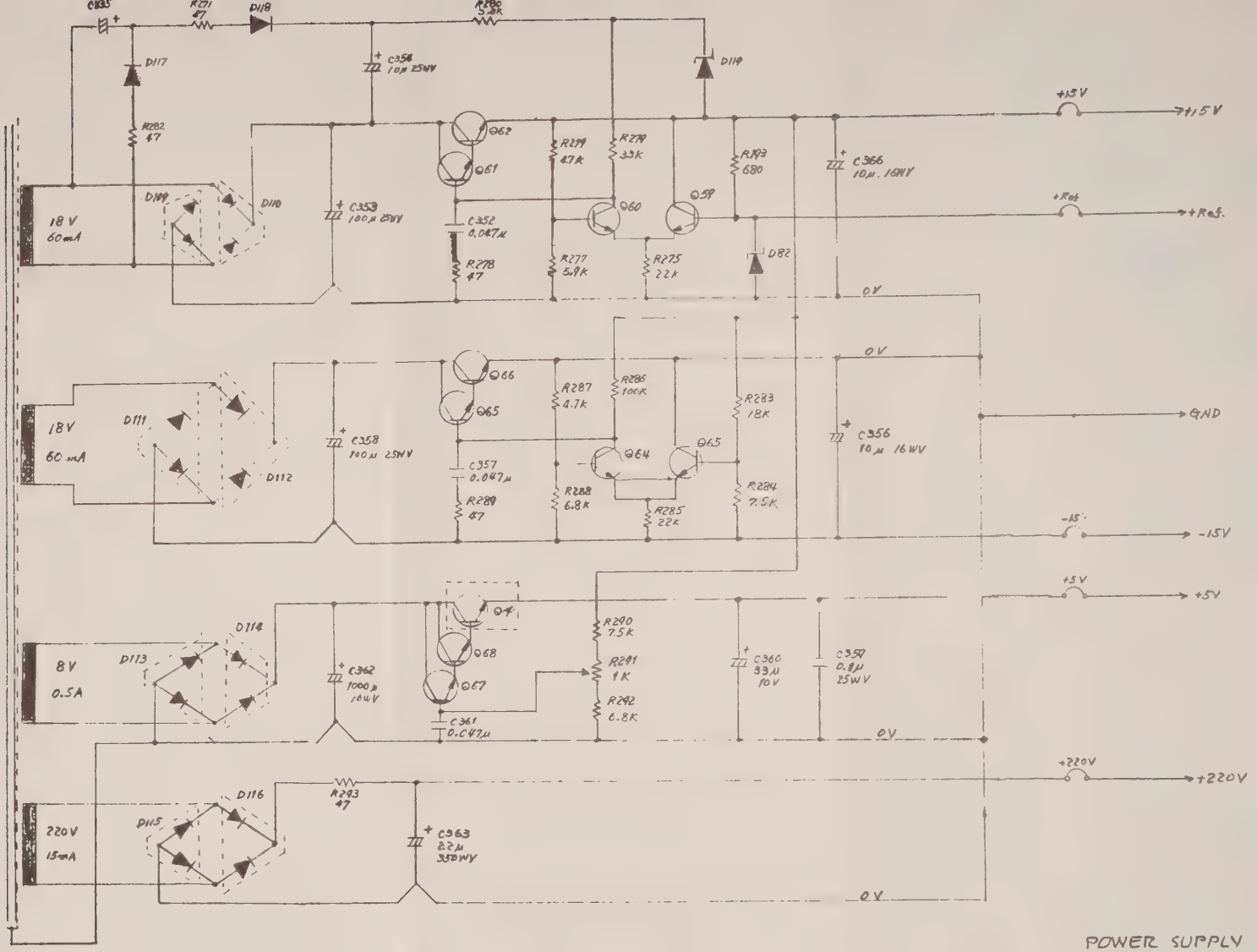


IF REF DIODES ARE CHANGED TO 9.0V VALUE MAKE CHANGES MARKED IN RED

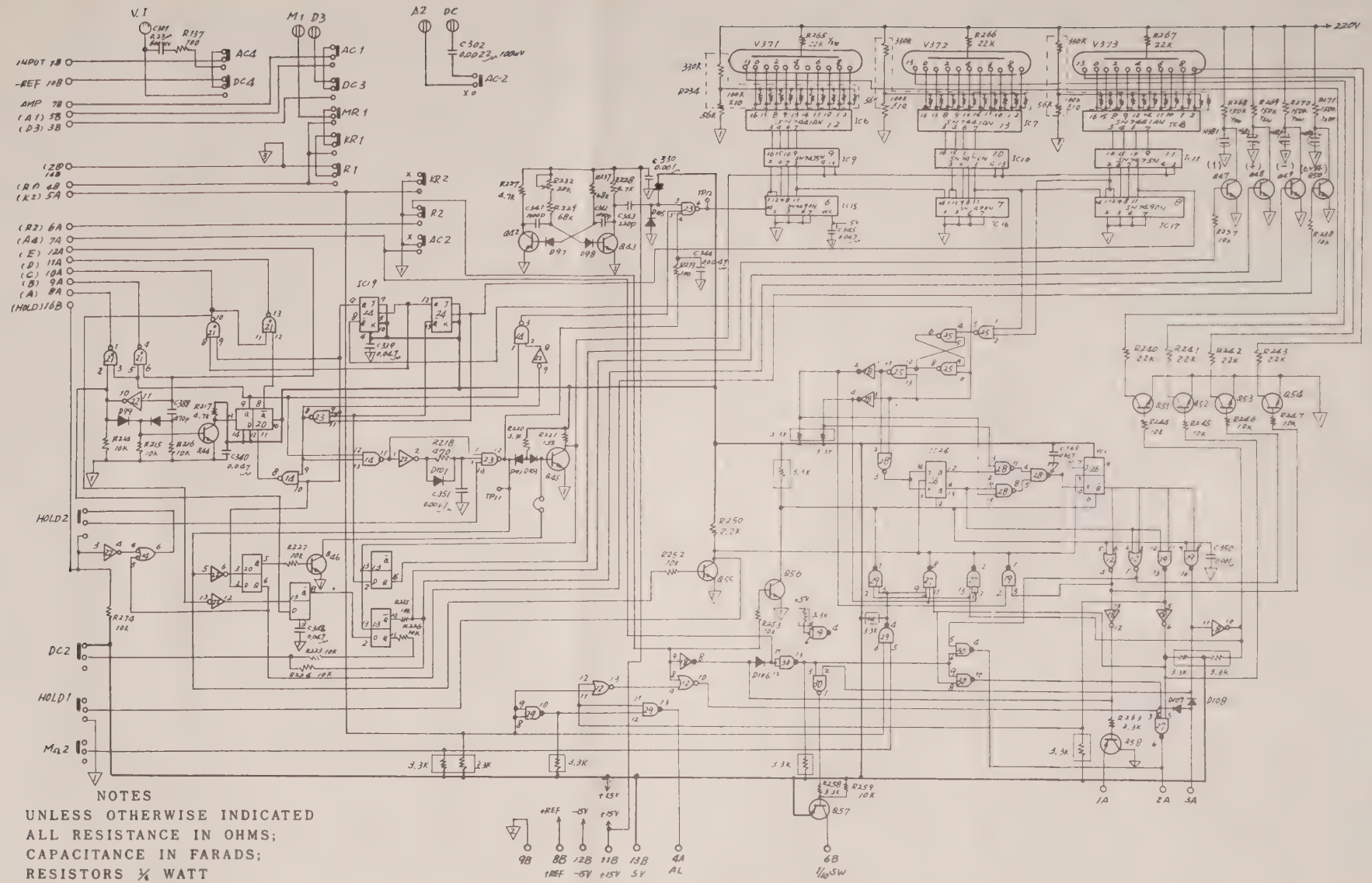
INPUT CIRCUIT SCHEMATIC
MODEL 8310



FUNCTION CONTROL
SCHEMATIC
MODEL 8310



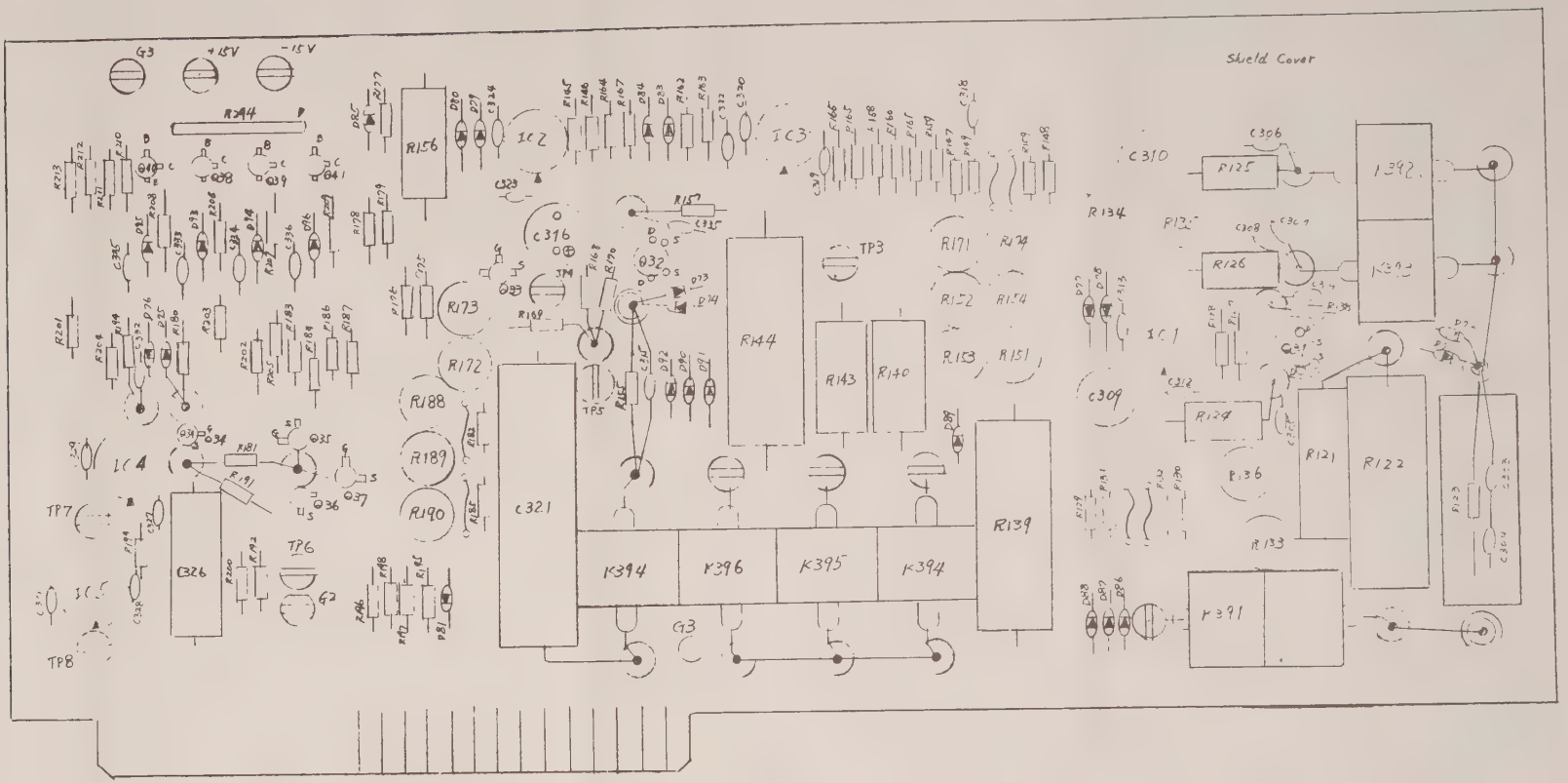
POWER SUPPLY
SCHEMATIC
MODEL 8310



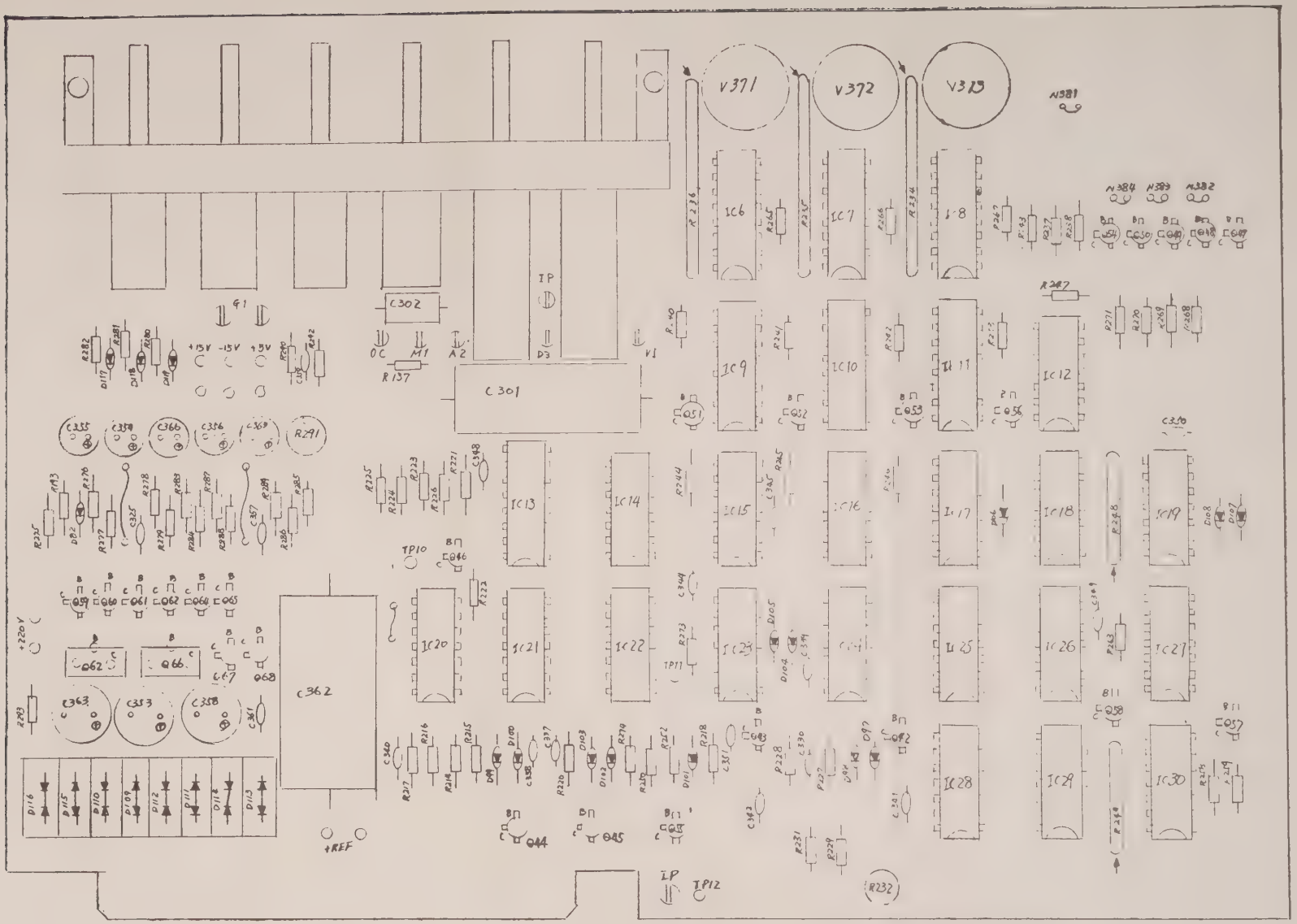
NOTES
UNLESS OTHERWISE INDICATED
ALL RESISTANCE IN OHMS;
CAPACITANCE IN FARADS;
RESISTORS ¼ WATT

M—

SCALER/AUTORANGE
SCHEMATIC
MODEL 8310



PARTS ASSEMBLY DRAWING
MODEL 5310



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PARTS ASSEMBLY DRAWING
MODEL 8310

ASSEMBLY PARTS LIST

Parts No.	Description
1	Panel Name
2	Panel
3	Filter
4	Filter Crossbar
5	Left Side-board
6	Right Side-board
7	Clutch Shaft
8	Fixed Clutch
9	Movable Clutch
10	Handle
11	Spring
12	Clutch Cover
13	Washer
14	Screw
15	Switch Base
16	Switch Holder
17	Knob Shaft
18	Knob
19	
20	Guard Spacer
21	Shield Cover
22	Rear Panel
23	Hind Leg
24	Transformer Holder

ELECTRIC PARTS LIST

Parts No.	Description	
Q1	Transistor Silicon NPN	2SD315D
T1	Power Transformer	TR-622B
P1	Binding Post	IP-TR
P2	Binding Post	IP-TB
P3	Binding Post	IP-TBLUE
P4	Binding Post	SQ0204
S1	Switch : Power	PS60322
C1	Capacitor FXD Ceramic	0.01 UF 500V
C2	Capacitor FXD Ceramic	0.01 UF 500V
J1	AC Power Connector	9328
J2	Hold Connector	SI-7501
J3	Connector	PBRS-48-T10
J4	Connector	PBRS-48-T10
J5	Teflon Jack	SKT-5BC
IC1	Linear IC	LM301A (Red) Takeda Spec.
IC2	Linear IC	LM301A (Red) Takeda Spec.
IC3	Linear IC	LM301A (Black) Takeda Spec.
IC4	Linear IC	LM301A (White) Takeda Spec.
IC5	Linear IC	LM311
IC6	Digital IC	SN7441AN
IC7	Digital IC	SN7441AN
IC8	Digital IC	SN7441AN
IC9	Digital IC	SN7475N
IC10	Digital IC	SN7475N
IC11	Digital IC	SN7475N
IC12	Digital IC	SN7402N
IC13	Digital IC	SN7475N
IC14	Digital IC	SN7400N
IC15	Digital IC	SN7490N
IC16	Digital IC	SN7490N

Parts No.	Description	
IC17	Digital IC	SN7490N
IC18	Digital IC	SN7405N
IC19	Digital IC	SN7401N
IC20	Digital IC	SN7474N
IC21	Digital IC	SN7401N
IC22	Digital IC	SN7404N
IC23	Digital IC	SN7410N
IC24	Digital IC	SN7473N
IC25	Digital IC	SN7400N
IC26	Digital IC	SN7473N
IC27	Digital IC	SN7412N
IC28	Digital IC	SN7400N
IC29	Digital IC	SN7401N
IC30	Digital IC	SN7401N
Q31	Junction FET (Twin)	ITS3948
Q32	Junction FET (Twin)	ITS3948
Q33	Junction FET	NF510
Q34	Junction FET	NF510
Q35	Junction FET	NF510
Q36	Junction FET	NF510
Q37	Junction FET	NF510
Q38	Transistor Silicon PNP	2SA495
Q39	Transistor Silicon PNP	2SA495
Q40	Transistor Silicon PNP	2SA495
Q41	Transistor Silicon PNP	2SA495
Q42	Transistor Silicon NPN	2SC269
Q43	Transistor Silicon NPN	2SC269
Q44	Transistor Silicon NPN	2SC269
Q45	Transistor Silicon NPN	2SC269
Q46	Transistor Silicon NPN	2SC269
Q47	Transistor Silicon NPN	2SC268A

Parts No.	Description	
Q48	Transistor Silicon NPN	2SC268A
Q49	Transistor Silicon NPN	2SC268A
Q50	Transistor Silicon NPN	2SC268A
Q51	Transistor Silicon NPN	2SC268A
Q52	Transistor Silicon NPN	2SC268A
Q53	Transistor Silicon NPN	2SC268A
Q54	Transistor Silicon NPN	2SC268A
Q55	Transistor Silicon NPN	2SC269
Q56	Transistor Silicon NPN	2SC269
Q57	Transistor Silicon PNP	2SA495
Q58	Transistor Silicon PNP	2SA495
Q59	Transistor Silicon NPN	2SC269
Q60	Transistor Silicon NPN	2SC269
Q61	Transistor Silicon NPN	2SC269
Q62	Transistor Silicon NPN	2SC1014
Q63	Transistor Silicon NPN	2SC269
Q64	Transistor Silicon NPN	2SC269
Q65	Transistor Silicon NPN	2SC269
Q66	Transistor Silicon NPN	2SC1014
Q67	Transistor Silicon NPN	2SC269
Q68	Transistor Silicon NPN	2SC269
D70	Diode Silicon	WG-713
D71	Diode Silicon	1S1516 (Black) Takeda Spec.
D72	Diode Silicon	1S1516 (Black) Takeda Spec.
D73	Diode Silicon	SD-101
D74	Diode Silicon	SD-101
D75	Diode Silicon	SD-101
D76	Diode Silicon	SD-101
D77	Diode Silicon	F-14B
D78	Diode Silicon	F-14B
D79	Diode Silicon	F-14B
D80	Diode Silicon	F-14B
D81	Diode Silicon	1S2192

Parts No.	Description	
D82	Diode Silicon	1S2192
D83	Diode Silicon	WG713
D84	Diode Silicon	WG713
D85	Diode Silicon	WG713
D86	Diode Silicon	WG713
D87	Diode Silicon	WG713
D88	Diode Silicon	WG713
D89	Diode Silicon	WG713
D90	Diode Silicon	WG713
D91	Diode Silicon	WG713
D92	Diode Silicon	WG713
D93	Diode Silicon	WG713
D94	Diode Silicon	WG713
D95	Diode Silicon	WG713
D96	Diode Silicon	WG713
D97	Diode Silicon	WG713
D98	Diode Silicon	WG713
D99	Diode Silicon	WG713
D100	Diode Silicon	WG713
D101	Diode Silicon	WG713
D102	Diode Silicon	WG713
D103	Diode Silicon	WG713
D104	Diode Silicon	WG713
D105	Diode Silicon	WG713
D106	Diode Silicon	WG713
D107	Diode Silicon	WG713
D108	Diode Silicon	WG713
D109	Diode Silicon, Composition	1S1850R
D110	Diode Silicon, Composition	1S1850
D111	Diode Silicon, Composition	1S1850R
D112	Diode Silicon, Composition	1S1850
D113	Diode Silicon, Composition	1S1850R

Parts No.	Description	
D114	Diode Silicon, Composition	1S1850
D115	Diode Silicon, Composition	1S1851R
D116	Diode Silicon, Composition	1S1851
D117	Diode Silicon, Composition	WG713
D118	Diode Silicon, Composition	WG713
D119	Diode Silicon, Composition	RD-9A
R121	Resistor FXD Metal Film	5M Ohm ±0.5% 1W
R122	Resistor FXD Metal Film	3.9M Ohm ±0.5% 1W
R123	Resistor FXD Metal Film	1M Ohm ±0.1% 1W
R124	Resistor FXD Metal Film	1M Ohm ±0.5% 1W
R125	Resistor FXD Metal Film	108.6k Ohm ±0.5% 1/4W
R126	Resistor FXD Metal Film	9.85k Ohm ±0.5% 1/4W
R127	Resistor FXD Metal Film	150k Ohm ±5% 1/4W
R128	Resistor FXD Metal Film	150k Ohm ±5% 1/4W
R129	Resistor FXD Metal Film	100k Ohm ±5% 1/4W
R130	Resistor FXD Metal Film	100k Ohm ±5% 1/4W
R131	Resistor FXD Metal Film	Adjust ±5% 1/4W
R132	Resistor FXD Metal Film	Adjust ±5% 1/4W
R133	Trim Pot	200k Ohm
R134	Trim Pot	5k Ohm
R135	Trim Pot	500 Ohm
R136	Trim Pot	10k Ohm
R137	Resistor FXD Carbon	100 Ohm ±5% 1/4W
R138	Resistor FXD Carbon	470 Ohm ±5% 1/4W
R139	Resistor FXD Metal Film	7.9M Ohm ±1% 1W
R140	Resistor FXD Metal Film	7.9k Ohm ±1% 1/4W
R141	Not Assigned	
R142	Not Assigned	
R143	Resistor FXD Metal Film	72k Ohm ±1% 1/4W
R144	Resistor FXD Metal Film	790 Ohm ±1% 1/2W
R145	Resistor FXD Metal Film	150k Ohm ±5% 1/4W

Parts No.	Description	
R146	Resistor FXD Metal Film	150k Ohm ±5% 1/4W
R147	Resistor FXD Metal Film	100k Ohm ±5% 1/4W
R148	Resistor FXD Metal Film	100k Ohm ±5% 1/4W
R149	Resistor FXD Metal Film	Adjust ±5% 1/4W
R150	Resistor FXD Metal Film	Adjust ±5% 1/4W
R151	Trim Pot	1M Ohm
R152	Trim Pot	1k Ohm
R153	Trim Pot	10k Ohm
R154	Trim Pot	100 Ohm
R155	Resistor FXD Carbon	10k Ohm ±5% 1W
R156	Resistor FXD Carbon	680 Ohm ±5% 1W
R157	Resistor FXD Carbon	120k Ohm ±5% 1/4W
R158	Resistor FXD Carbon	100k Ohm ±5% 1/4W
R159	Resistor FXD Carbon	100k Ohm ±5% 1/4W
R160	Resistor FXD Carbon	180 Ohm ±5% 1/4W
R161	Resistor FXD Carbon	180 Ohm ±5% 1/4W
R162	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R163	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R164	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R165	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R166	Resistor FXD Metal Film	10k Ohm ±1% 1/10W
R167	Resistor FXD Metal Film	10k Ohm ±1% 1/10W
R168	Resistor FXD Metal Film	40k Ohm ±1% 1/10W
R169	Resistor FXD Metal Film	84k Ohm ±1% 1/10W
R170	Resistor FXD Metal Film	80k Ohm ±1% 1/10W
R171	Trim Pot	10k Ohm
R172	Trim Pot	10k Ohm
R173	Trim Pot	5k Ohm
R174	Trim Pot	10k Ohm
R175	Resistor FXD Metal Film	34k Ohm ±1% 1/10W

Parts No.	Description	
R176	Resistor FXD Metal Film	4.2k Ohm ± 1% 1/10W
R177	Resistor FXD Carbon	100k Ohm ±5% 1/4W
R178	Resistor FXD Carbon	15k Ohm ±5% 1/4W
R179	Resistor FXD Carbon	15k Ohm ±5% 1/4W
R180	Resistor FXD Metal Film	110k Ohm ±1% 1/8W
R181	Resistor FXD Metal Film	110k Ohm ±1% 1/8W
R182	Resistor FXD Metal Film	4.2k Ohm ±5% 1/4W
R183	Resistor FXD Metal Film	62k Ohm ±1% 1/10W
R184	Resistor FXD Metal Film	10k Ohm ±1% 1/10W
R185	Resistor FXD Metal Film	4.2k Ohm ±5% 1/4W
R186	Resistor FXD Metal Film	62k Ohm ±1% 1/10W
R187	Resistor FXD Metal Film	10k Ohm ±1% 1/10W
R188	Trim Pot	5k Ohm
R189	Trim Pot	5k Ohm
R190	Trim Pot	10k Ohm
R191	Resistor FXD Carbon	1M Ohm ±5% 1/2W
R192	Resistor FXD Carbon	680 Ohm ±5% 1/4W
R193	Resistor FXD Carbon	680 Ohm ±5% 1/4W
R194	Resistor FXD Carbon	110k Ohm ±5% 1/4W
R195	Resistor FXD Carbon	27k Ohm ±5% 1/4W
R196	Resistor FXD Carbon	27k Ohm ±5% 1/4W
R197	Resistor FXD Carbon	470 Ohm ±5% 1/4W
R198	Resistor FXD Carbon	470 Ohm ±5% 1/4W
R199	Resistor FXD Carbon	4.7k Ohm ±5% 1/4W
R200	Resistor FXD Carbon	4.7k Ohm ±5% 1/4W
R201	Resistor FXD Carbon	2.2k Ohm ±5% 1/4W
R202	Resistor FXD Carbon	270k Ohm ±5% 1/4W
R203	Resistor FXD Carbon	270k Ohm ±5% 1/4W
R204	Resistor FXD Carbon	120k Ohm ±5% 1/4W
R205	Resistor FXD Carbon	120k Ohm ±5% 1/4W
R206	Resistor FXD Composition	22k Ohm ±5% 1/4W
R207	Not Assigned	

Parts No.	Description	
R208	Not Assigned	
R209	Not Assigned	
R210	Resistor FXD Carbon	3.3k Ohm ±5% 1/4W
R211	Resistor FXD Carbon	3.3k Ohm ±5% 1/4W
R212	Resistor FXD Carbon	3.3k Ohm ±5% 1/4W
R213	Resistor FXD Carbon	3.3k Ohm ±5% 1/4W
R214	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R215	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R216	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R217	Resistor FXD Carbon	4.7k Ohm ±5% 1/4W
R218	Resistor FXD Carbon	470 Ohm ±5% 1/4W
R219	Not Assigned	
R220	Resistor FXD Carbon	3.3k Ohm ±5% 1/4W
R221	Resistor FXD Carbon	1.5k Ohm ±5% 1/4W
R222	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R223	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R224	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R225	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R226	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R227	Resistor FXD Metal Film	4.7k Ohm ±1% 1/4W
R228	Resistor FXD Metal Film	4.7k Ohm ±1% 1/4W
R229	Resistor FXD Metal Film	68k Ohm ±1% 1/4W
R230	Resistor FXD Metal Film	68k Ohm ±1% 1/4W
R231	Not Assigned	
R232	Trim Pot	20k Ohm
R233	Not Assigned	
R234	Resistor : Composition	MR-13-1
R235	Resistor : Composition	MR-13-1
R236	Resistor : Composition	MR-13-1
R237	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R238	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R239	Not Assigned	

Parts No.	Description	
R240	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R241	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R242	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R243	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R244	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R245	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R246	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R247	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R248	Resistor : Composition	MR-6-1
R249	Resistor : Composition	MR-6-1
R250	Resistor FXD Carbon	2.2k Ohm ±5% 1/4W
R251	Not Assigned	
R252	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R253	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R254	Not Assigned	
R255	Not Assigned	
R256	Not Assigned	
R257	Not Assigned	
R258	Resistor FXD Carbon	3.3k Ohm ±5% 1/4W
R259	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R260	Not Assigned	
R261	Not Assigned	
R262	Not Assigned	
R263	Resistor FXD Carbon	3.3k Ohm ±5% 1/4W
R264	Not Assigned	
R265	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R266	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R267	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R268	Resistor FXD Carbon	100k Ohm ±5% 1/2W
R269	Resistor FXD Carbon	150k Ohm ±5% 1/2W
R270	Resistor FXD Carbon	150k Ohm ±5% 1/2W
R271	Resistor FXD Carbon	150k Ohm ±5% 1/2W

Parts No.	Description	
R272	Not Assigned	
R273	Resistor FXD Carbon	100 Ohm ±5% 1/4W
R274	Resistor FXD Carbon	10k Ohm ±5% 1/4W
R275	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R276	Resistor FXD Metal Film	4.7k Ohm ±1% 1/4W
R277	Resistor FXD Metal Film	5.9k Ohm ±1% 1/4W
R278	Resistor FXD Carbon	47 Ohm ±5% 1/4W
R279	Resistor FXD Carbon	33k Ohm ±5% 1/4W
R280	Resistor FXD Carbon	3.3k Ohm ±5% 1/4W
R281	Resistor FXD Carbon	47 Ohm ±5% 1/4W
R282	Resistor FXD Carbon	47 Ohm ±5% 1/4W
R283	Resistor FXD Metal Film	18k Ohm ±1% 1/4W
R284	Resistor FXD Metal Film	7.5k Ohm ±1% 1/4W
R285	Resistor FXD Carbon	22k Ohm ±5% 1/4W
R286	Resistor FXD Carbon	100k Ohm ±5% 1/4W
R287	Resistor FXD Metal Film	4.7k Ohm ±1% 1/4W
R288	Resistor FXD Metal Film	6.8k Ohm ±1% 1/4W
R289	Resistor FXD Carbon	47 Ohm ±5% 1/4W
R290	Resistor FXD Metal Film	7.5k Ohm ±1% 1/4W
R291	Trim Pot	1k Ohm
R292	Resistor FXD Metal Film	6.8k Ohm 1% 1/4W
R293	Resistor FXD Carbon	47 Ohm 5% 1/4W
R294	Resistor : Composition	MR-6-1
C301	Capacitor FXD Metal Film	0.22μF 600V
C302	Capacitor FXD Mylar	0.0022μF 100V
C303	Capacitor FXD Dipped Mica	5PF ±10% 500V
C304	Capacitor FXD Dipped Mica	5PF ±10% 500V
C305	Capacitor FXD Dipped Mica	10PF ±10% 300V
C306	Capacitor FXD Dipped Mica	15PF ±10% 300V
C307	Capacitor FXD Dipped Mica	130PF ±10% 300V
C308	Capacitor FXD Dipped Mica	68PF ±10% 300V

Parts No.	Description	
C309	Capacitor Ceramic Trimer	6PF
C310	Capacitor Ceramic Trimer	20PF
C311	Capacitor Ceramic Trimer	20PF
C312	Capacitor FXD Ceramic	22PF ±10%
C313	Capacitor FXD Ceramic	0.047μF
C314	Capacitor FXD Ceramic	0.022μF
C315	Capacitor FXD Ceramic	330PF ±10%
C316	Capacitor FXD Electro Alumi	100μF 16V
C317	Not Assigned	
C318	Capacitor FXD Ceramic	0.022μF
C319	Capacitor FXD Ceramic	150PF ±10%
C320	Capacitor FXD Ceramic	0.047μF
C321	Capacitor FXD Metal Film	1μF ±10% 200V
C322	Capacitor FXD Ceramic	3PF
C323	Capacitor FXD Ceramic	33PF ±10%
C324	Capacitor FXD Ceramic	0.047μF
C325	Capacitor FXD Ceramic	0.022μF
C326	Capacitor FXD Metal Film	0.22μF ±10% 200V
C327	Capacitor FXD Ceramic	33PF ±10%
C328	Capacitor FXD Ceramic	0.001μF
C329	Capacitor FXD Ceramic	0.047μF
C330	Capacitor FXD Ceramic	0.001μF
C331	Capacitor FXD Ceramic	0.047μF
C332	Capacitor FXD Ceramic	0.047μF
C333	Capacitor FXD Ceramic	100PF ±10%
C334	Capacitor FXD Ceramic	100PF ±10%
C335	Capacitor FXD Ceramic	100PF ±10%
C336	Capacitor FXD Ceramic	100PF ±10%
C337	Capacitor FXD Ceramic	470PF ±10%
C338	Capacitor FXD Ceramic	470PF ±10%
C339	Capacitor FXD Ceramic	0.047μF
C340	Capacitor FXD Ceramic	0.047μF

Parts No.	Description	
C341	Capacitor FXD Metal Film	1000PF ±5% 50V
C342	Capacitor FXD Metal Film	1000PF ±5% 50V
C343	Capacitor FXD Ceramic	220PF ±10%
C344	Capacitor FXD Ceramic	0.0047μF
C345	Capacitor FXD Ceramic	0.047μF
C346	Capacitor FXD Dipped Mica	20PF 300V
C347	Not Assigned	
C348	Capacitor FXD Ceramic	0.047μF
C349	Capacitor FXD Ceramic	0.047μF
C350	Capacitor FXD Ceramic	0.001μF
C351	Capacitor FXD Ceramic	0.0047μF
C352	Capacitor FXD Ceramic	0.047μF
C353	Capacitor FXD Electro Alumi	100μF 25V
C354	Capacitor FXD Electro Alumi	10μF 25V
C355	Capacitor FXD Electro Alumi	10μF 25V
C356	Capacitor FXD Electro Alumi	10μF 16V
C357	Capacitor FXD Ceramic	0.047μF
C358	Capacitor FXD Electro Alumi	100μF 25V
C359	Capacitor FXD Ceramic	0.1μF 25V
C360	Capacitor FXD Electro Alumi	33μF 10V
C361	Capacitor FXD Ceramic	0.047μF
C362	Capacitor FXD Electro Alumi	1000μF 16V
C363	Capacitor FXD Electro Alumi	2.2μF 315V
C364	Not Assigned	
C365	Not Assigned	
C366	Capacitor FXD Electro Alumi	10μF 16V
V371	Display Tube	B5750
V372	Display Tube	B5750
V373	Display Tube	B5750
N381	Neon Lamp	NE 2QD-TR
N382	Neon Lamp	NE 2QD-TR

Parts No.	Description	
N383	Neon Lamp	NE 2QD-TR
N384	Neon Lamp	NE 2QD-TR
K391	Reed Switch	MR-138
K392	Reed Switch	MRR-2
K393	Reed Switch	MRR-2
K394	Reed Switch	MRR-2
K395	Reed Switch	MRR-2
K396	Reed Switch	MRR-2
K397	Reed Switch	MRR-2
L1	Filter Coil	
F1	Fuse Holder	F-7155
	Fuse (Slow Blow)	19195 (0.2 A)

88768

MP MASTER
MA28069